page of Vol. 1, of the Proceedings, and for providing a cover for future numbers of the Proceedings, were adopted.

On motion, Mr. Price, Mr. Fraley, and Mr. Colwell, were appointed a committee to take into consideration and report at the next meeting upon the subject of providing a lot for the future building of the Society.

And the Society was then adjourned.

Stated Meeting, April 15, 1864.

Present, fifteen members.

Dr. Wood, President, in the Chair.

Letters acknowledging the receipt of publications were received from the Natural History Society of Nuremberg, November 14th, and the Royal Society at Upsal, September 15th, 1863.

Letters of invoice were received from the Imperial Society of Naturalists at Moscow, September 6–12; the Royal Society at Upsal, October 15th; the Royal Society at Berlin, November 30th; the Royal Society at Stockholm, November 18th; the Royal Society at Munich, November 20th, 1863.

Donations for the Library were announced from the Royal Academies and Societies at Stockholm, Upsal, Moscow, Berlin, and Munich; the Geological Society at Berlin, the Natural History Society at Nuremberg, and the Zoological Society at Frankfort on the Maine; the Bureau of Public Instruction at Paris; MM. Desnoyers and Boucher de Perthes, Prof. Hennessy, Blanchard & Lea, and the Rev. Mr. Barnes, of Philadelphia.

Donation for the Album, from Mr. Isaac Lea, of the portrait of Dr. George Jager.

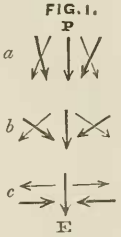
On motion, the Natural History Society of Nuremberg was placed on the list of correspondents to receive the Proceedings.

Mr. Chase made remarks upon the subject of magnetism, and in further illustration of what he had advanced at previous meetings.

Barlow's and Lecount's laws for the distribution of the induced magnetism in masses of iron, are precisely the same as would follow from the relative centrifugal motions of different portions of the earth, provided the magnetic axis coincided with the axis of rotation. It is therefore reasonable to presume that they accurately represent the superficial motions or currents on which the magnetism depends, and to hope that a careful study will enable us to detect the cause of the oscillations that polarize the air and all other bodies that are capable of vibrating in harmony with it.

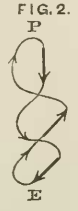
If the earth were stationary, the sun's heat would produce a constant ascending current over the whole meridian, which would be supplied by colder lateral currents from each side. These currents are represented in Fig. 1. P, is the pole; E, the equator; *a*, *b*, *c*, the lateral currents. The light arrows represent the direction of the upper, overflowing, warm air, and the dark ones the direction of the lower, cool air. The effect of these several currents would be a mechanical atmospheric polarity, precisely analogous to that which was indicated by our experiments upon the control of the magnetic needle by mechanical vibrations.

FIG. 1.



In consequence of the earth's rotation, the tendency shown in Fig. 1, is communicated only at the instant of noon. At all other times, the flow of the cool air towards the equator, and of the warm air to the coldest portions of the globe, is modified by the earth's motion, so as to produce currents analogous to those represented in Fig. 2. P represents, in this instance, not the true pole, but the point of greatest cold. The warm air rises at E, and flows towards P until it becomes sufficiently cooled to sink to the earth. Still flowing onward it absorbs the heat of the earth, until it is so rarefied as to rise again. This process of alternate rise and fall, is continued until the air reaches P, and then returns by the same law and in a similar manner, to E.* These currents, which are flowing at all hours, and in

FIG. 2.



* Halley, in 1686 (Phil. Trans., No. 183), explained the trade wind, and the necessity of a reverse upper current, but he found it "very hard to conceive why the limits of the trade wind should be fixt about the 30th degree of latitude

all portions of the earth, produce an atmospherical directive energy towards the poles of maximum cold, which appear, according to Sir David Brewster, to coincide with the magnetic poles.

Now, if we consider that in addition to these permanent currents, there is a continual motion of silent convection, the warm air rising, and the cold air descending in parallel columns, like the particles in a vessel of boiling water,* and if we remember that the warm air is charged with moisture which is condensed as it ascends, parting thereby with much of its heat and electricity, we can hardly deem it necessary to adopt Dr. Dalton's hypothesis that ferruginous matter is the source of atmospheric magnetism. Still the existence of vaporized iron in the air undoubtedly contributes an increased intensity to the magnetic currents, and it may probably be an important agent in the production of magnetic storms.

The two vibratory systems represented in Figs. 1 and 2, are conjoined during the hours when the sun is above the horizon, and the laws of motion applicable to the first system correspond precisely, as we shall see hereafter, with the laws of the solar-diurnal variation deduced from General Sabine's admirable discussions of the St. Helena observations. It is not so easy to explain in its minute details the comparatively insignificant lunar-diurnal variation, but I am convinced that the aerial currents produced by lunar attraction, will sufficiently account for all the magnetic influence that is due to the moon exclusively. The changing barometric pressure, and the deposition of dew during the night, modify these currents in such a way as to disguise the simple effect of any slight disturbing cause; nevertheless, there is a manifest tendency underneath all the disguise, to maxima and minima at the precise hours when they ought to occur in consequence of the moon's attraction.

In the influence of the violet rays upon magnets, the connection of the violet rays with the tension of brass in the polariscope, the excitement of magnetic vibrations in iron by percussion and torsion, the increase of magnetism by cold and its diminution by heat, and the

all around the globe." I am not aware that any one has ever pointed out the combined effects of convection, absorption of heat from the earth, and the daily superposition of the currents represented in Figs. 1 and 2.

* It is very probable that this motion of convection is a more important agency than has generally been supposed. If we close the lower drafts of a common air-tight stove, and open a register immediately over the fire, the cold air does not rush directly to the draft pipe; but it falls with great velocity to the surface of the fuel, as may be shown by dropping pieces of paper through the register.

general correspondence between Challis's laws of molecular action and the laws of attraction and rotation, we may find interesting evidences of the unity of force which all modern discovery tends to demonstrate, and in that unity a sufficient explanation of the observed annual and secular variations of the magnetic needle, the disturbing magnetic effects of auroras and solar spots, the changes of the wind, and storms of every kind. Some of the well-known phenomena of storms furnish a ready test of the principles I have attempted to establish.

Although Fig. 2 represents the general tendency of a particle of air, it is not probable that all the atmosphere, or even, perhaps, any considerable portion of it, follows so regular a path. In the upper regions, where the air is not so much affected by the radiation of the earth, it may oscillate, as suggested by Redfield, "from centrifugal action towards the equator, and gravitation towards the poles,"* and between the points of decussation there are undoubtedly eddies which have a general movement eastward or westward, in accordance with the theory of M. Dové. These several currents are represented in Fig. 3. The disturbances of the æther, dependent upon the relative attractions of the earth and sun, probably produce tides corresponding in time with those of the barometer, which must modify the atmospheric currents. The character of these disturbances may be inferred from Fig. 4, the horizontal arrows representing the course of the æther under the solar influence, and the curved arrows its course under the combined attraction of the earth and sun.

FIG. 3.

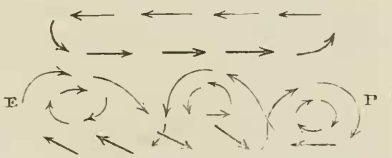
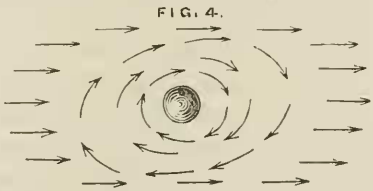


FIG. 4.



Having thus ascertained the causes and directions of the principal normal currents, the ordinary theory of winds enables us to understand the effect of mountain peaks, deserts, forests, rivers, and ocean-streams. Every point of the earth's surface that accumulates or radiates an undue amount of heat, becomes a centre of polarity with an attractive energy that disturbs the atmospheric equilibrium, tending to produce wind and rain. If the disturbance is confined to a

* Silliman's Journal, vol. 25, p. 130.

limited area, there is a well-known cyclonic tendency, the portion of the eddy which is nearest the equator, *generally* flowing eastward. Mr. Galton* has ingeniously shown that in descending cyclones, the direction may be reversed, and I should expect a similar reversal to be of frequent occurrence in the neighborhood of some of the powerful ocean-currents, at points where they tend to produce backward eddies. Such points are found midway between the Sandwich Islands and California, about 35° west of Chili, near the west coast of New Holland, in the Indian Ocean, northeast of Madagascar, and in other places.

The effect of ocean-currents in producing cyclones, and directing their course, is well illustrated by the repeated observations that have been made in the Gulf Stream. Prof. Lesley's interesting account of the series of storms encountered by the Canada on her one hundredth voyage,† exhibits the natural consequences of the friction of two belts of air at different temperatures, moving in opposite directions. The warm air over the Gulf Stream, and the cold air over the Arctic currents that flow nearer to the American continent, are both borne very nearly in their normal directions, but with the approach of winter their parallelism becomes almost vertical, the cold belt becomes wider from its encroachment upon the land, and the vortices that arise from their concurrence are frequently brought down to the surface of the ocean, instead of taking place in the higher regions of the air, as they usually do during summer.

While sudden, violent tempests that are occasioned by local disturbances over a limited area, are almost necessarily cyclonic, I am inclined to adopt Espy's theory with regard to long storms, that usually "the wind will blow in towards a line rather than towards a point," and in favor of this hypothesis as well as of the periodicity of weather-changes, I would suggest the following explanation.

The normal currents of the atmosphere (Figs. 2, 3) are subject, as we have seen, to a daily disturbance by the sun's action (Fig. 1). This disturbance, like the moon's tidal action, is cumulative, and has a constantly increasing tendency to overcome the aerial polarity. The gathering wave follows the sun until it is saturated with vapor, and as soon as it becomes powerful enough to influence the normal current, it must produce a shifting of the wind, and a deposition of moisture. The equilibrium of temperature is then restored, to be subjected anew to the same constant disturbance and the same stormy culmination.

* Phil. Mag., Sept., 1863.

† Proc. Amer. Philos. Soc., April 1, 1864.

[My attention has just been called by the last number of the Journal of the Franklin Institute, to some extracts from the London Athenæum for January, announcing a paper on Magnetic Storms, which was read by Mr. Airy before the Royal Society. I take this early opportunity to acknowledge that the Astronomer Royal appears, in some measure, to have anticipated the views upon the sources of terrestrial magnetism, which I have recently had the honor of communicating to the Philosophical Society.

As I have not yet seen the paper in question, I do not know how far the priority may extend; whatever may be its limits, it gives me pleasure to yield my claims to so distinguished and cautious an investigator, and to find that my own independent conclusions have been so ably corroborated. And I believe I have good grounds for hoping, that in the specific solar action which I have pointed out, Mr. Airy will find the precise "occasional currents produced by some action or cessation of action of the sun," for which he is looking. May 14.]

Mr. Peale made a communication on stone implements.

Pending nominations, Nos. 508 to 522, and new nominations, No. 523, were read, and the Society proceeded to ballot for members.

Mr. Fraley, on behalf of the Committee on the purchase of a building lot, reported progress.

All other business having been transacted, the ballot-boxes were opened by the presiding officer, and the following persons were declared duly elected members of this Society.

Benjamin V. Marsh, of Philadelphia.
James T. Hodge, of Newburg, N. Y.
James Kirchhoff, of Heidelberg, Germany.
Francis J. Pictet, of Geneva, Switzerland.
Benjamin Studer, of Zurich, Switzerland.
Alphonse Count de Gasparin, of Paris.
Peter Tunner, of Leoben, in Styria.
M. Thury, of Geneva, Switzerland.
Rev. Dr. Tholuck, of Halle-an-der-Saale.
Carl Schinz, of Offenburg, Baden.
William Sellers, of Philadelphia.
Richard S. Smith, of Philadelphia.
Alexander Wilcocks, M.D., of Philadelphia.

And the Society was adjourned.